Southwest Fisheries Science Center
Administrative Report H-93-03

A COMPARISON OF BAITED VIDEO CAMERA AND KALI LONGLINE FOR INDEXING THE ABUNDANCE OF JUVENILE OPAKAPAKA (*PRISTIPOMOIDES FILAMENTOSUS*)

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March 1993

NOT FOR PUBLICATION

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ABSTRACT

Thirty-nine longline and video stations were completed off four embayments on the main Hawaiian Islands (MHI) of Oahu, Maui and Kauai. Operations were conducted from the NOAA ship *Townsend Cromwell* cruise TC-92-04 during May 1992. The major objective was to compare the precision, accuracy, and efficiency of a video camera system and longlines for indexing the abundance of juvenile opakapaka (*Pristipomoides filamentosus*).

A nuisance fish, *Lagocephalus hypselogeneion*, ranked first in abundance and opakapaka was second in both video films and longline catches. The largest catches of juvenile opakapaka (93% of 58 fish) occurred at longline stations off windward Oahu. The video index of maximum number seen (MAXNO, the log-transformed mean of three camera drops) for opakapaka was best correlated with longline catch-per-unit-effort (lnCPUE) using data from windward Oahu ($r = 0.79$, $p < 0.001$, $n = 15$). The variability of these data for video MAXNO was nominally less than that of the longline lnCPUE (coefficient of variation = V = 81% vs 91%, respectively). Sample sizes of 33 stations for longline and 17 stations for video were estimated necessary to detect 50% changes in abundance for opakapaka, using windward Oahu stations for which there were three quantitative drops ($n = 10$). A sample size of 18 stations would be needed to detect a 50% change if two camera drops, instead of three, were used per station. This would reduce the total effort from 51 to 36 drops per station, and sampling could be done with acceptable precision within a reasonable period of time (2-3 days).

INTRODUCTION

Bottom fish species (F. Lutjanidae) support an important commercial fishery around the main Hawaiian Islands (MHI) and the Northwest Hawaiian Islands (NWHI). The pink snapper or "opakapaka," *Pristipomoides filamentosus*, has been one of the most important species in terms of landings (20-30% of total weight) and revenue for many years (Ralston and Polovina 1982; Humphreys 1986; Kawamoto 1991, 1992; Anon. 1992). Research on adult *P. filamentosus* has included studies on sexual maturity and growth (Ralston and Miyamoto 1983; Kikkawa 1984; Okamoto 1993), food intake (Haight 1993), and distribution (Kami 1973; Moffitt 1980). Relatively few pelagic specimens of opakapaka have been collected, so little is known about their life history prior to settlement (Leis 1987).

Exploratory research on juvenile *P. filamentosus* has been conducted by the Honolulu Laboratory of the National Marine Fisheries Service (NMFS) since 1988. This has included initial habitat description, population monitoring, and work on age and growth of juveniles at Kaneohe Bay, Oahu (Parrish 1989; R. B. Moffitt and F. A. Parrish unpubl. manuscript; K. Landgraf and R. Humphreys unpubl. data). Recent work has focused on the distribution of populations of juvenile opakapaka throughout the Hawaiian archipelago (Ellis et al. 1992; NMFS unpubl. data). Previous sampling techniques included trawling, trapping, and handline fishing.

This study made use of a video camera as a new technique for studying juvenile opakapaka populations in Hawaiian insular shelf habitats. Still and video cameras have been used to sample other marine habitats; e.g., as a comparison method and in conjunction with submersible surveys (Grassle et al. 1975; Grimes et al. 1982; Gooding et al. 1988; Moffitt and Parrish 1992); as a tool for studying the natural history of otherwise inaccessible abyssal species (Isaacs and Schwartzlose 1975; Lampitt and Burnham 1983; Wilson and Smith 1984; Laver et al. 1985; Priede et al. 1990; Armstrong et al. 1992); and as a means for estimating the abundances of abyssal fish and deep-ocean benthic species (Miller 1975; Uzmann et al. 1977; Priede et al. 1990; Matlock et al. 1991; Armstrong et al. 1992). This paper compares the precision, accuracy, and efficiency of the video camera system by relating visual indexes of fish abundance recorded on video film to longline catch-per-unit-effort (CPUE). We emphasize our data for the pink snapper but include complementary data for Bleeker's balloonfish or "puffers," *Lagocephalus hypselogeneion*, because of the puffers' numerical dominance in both types of samples.

MATERIALS AND METHODS

Sampling

Longline and video camera operations were conducted for 10 days (May 19-28, 1992) at Kaneohe and Kahana Bays, windward Oahu; Kahului Bay, Maui; and Hanalei Bay, Kauai (Fig. 1), on *Townsend Cromwell* cruise TC-92-04. Longlines were set in conjunction with video camera drops on 3 days each off Maui and Kauai and 4 days off Oahu (3 days off Kaneohe Bay and 1 day off of Kahana Bay). Longlines were deployed from the NOAA vessel *Townsend Cromwell*; video camera operations used two auxiliary craft.

Bottom longline operations used modified Kali longlines (described by Shiota, 1987) with 30 3.2-m PVC droppers. Each of the droppers was individually weighted and buoyed. The main line consisted of a 9.4-mm diameter floating polypropylene line, approximately 550 m long, which was weighted and buoyed at both ends. Droppers were attached along the main line every 18.3 m. A 28.2-cm long, 9.07-kg test hard monofilament branch leader and 12.8-cm long, 3.63-kg test hard monofilament hook leader were used. Each dropper had five leaders spaced 46.2 cm apart, with size 12 Izuo circle hooks (AH style) for a total of 150 hooks per longline set. Stripped squid was used as bait. The standard soak time was 30 minutes, with three to four deployments completed each day. Spacing between deployments was approximately 1 km longshore.

Two separate, 8-mm video camera systems, using 2-hr tapes and rechargeable NiCd batteries (6V, 2.4 amp hr), were used for the video drops. Each video camera was equipped with a No. 1 diopter magnification lens and a wide angle zoom lens with a red filter attached for underwater correction. Camera focus, sensitivity, and white balance were manually adjusted, but an auto-aperture setting was used. The focal distance for both video cameras was fixed at 2.13 m and the zoom focal length was set at 11 mm. Each video camera was enclosed in an underwater housing and secured in a weighted frame constructed of 12.7-mm electrical conduit (Fig. 2). Bait containers were positioned 60 cm in front of the camera lens, mounted on 12.7-mm plastic polymer rods. The bait canisters contained a single (≈ 0.5-kg) mackerel (*Scomber* sp) and one whole squid (*Loligo* sp) tie-wrapped to the outside. The camera systems were manually lowered to the bottom using polypropylene line (1-cm diameter) and later raised to the surface aided by outboard engine power. Cameras were marked by a buoy and allowed to set stationary on the bottom for a standard 10 min before retrieval. One to three camera drops were completed for each longline deployment.

Depth of the camera drops and longline sets was determined by depth sounders aboard the research vessels. Position of the longline and camera drops was determined by GPS or a sighting compass. Video camera drops and longline sets were done on parallel tracks within 50-75 m of each other.

Types of Data

Species presence, total number per species, and the number of hooks lost were recorded for each longline set. Species presence and duration of squid bait attachment to the bait canister (BTM) were recorded for each video film. In addition three indexes of abundance were scored and recorded for each species: maximum number (MAXNO), time to first appearance (TFAP), and total duration on film (TOTTM). Bottom sediments were qualitatively scored from video records as mud, sand, granular sand, and rubble; invertebrate holes or trails were also noted. Relief was qualitatively scored as flat, sloped, 'waves,' and large structure. The average number of fish recorded was calculated for nine films (three video stations) using a mean, weighted by the duration of each occurrence:

$$\overline{X}_W = \frac{\sum_{h=1}^{n} X_h \cdot N_h}{N} , \quad (1)$$

where $\overline{X}_W$ = the weighted average number of fish, n = total number of occurrences, X_h = total number of fish seen in the h<u>th</u> occurrence, N_h = duration (sec) of the h<u>th</u> occurrence, and $N = \Sigma N_h = 600$ sec. All indexes used for statistical comparisons were transformed to natural logs prior to analyses. Video indexes were calculated as means to account for multiple drops per station. Video indexes were derived in two forms: mean of logs (ML):

$$ML = \frac{\sum_{i=1}^{n} \ln(x_i + 1)}{n} , \quad (2)$$

and log of means (LM):

$$LM = \ln\left[\left(\frac{\sum_{i=1}^{n} x_i}{n}\right) + 1\right] , \quad (3)$$

where x_i = individual datum for a variable, and n = number of drops per station. The longline index was log-transformed individual data [ln (catch + 1)]. The number of stations where each species was caught or seen also was tallied for each gear type.

Statistics

A matrix of Pearson's correlations was calculated (SAS Institute Inc. 1985) using log transformed variables to determine the interrelationships among all of the video and longline indexes. Log-transformed data were approximately normal. Multiple regression (SAS Institute Inc. 1985) was used to determine the effect of competition between opakapaka and puffers for hooks based on the following model:

$$Y = aX_1 + bX_2 + \epsilon, \qquad (4)$$

where Y = ln (opakapaka video MAXNO), X_1 = ln (no. hooks lost + no. puffers caught), and X_2 = ln (no. opakapaka caught). The model was run as a forward regression without an intercept and with an entry level for significance equal to $P \leq 0.10$. The precision (repeatability) of video and longline was described by the coefficient of variation (*V*; Sokal and Rohlf 1981; Zar 1984):

$$V = \left(\frac{SD}{mean}\right) \times 100(\%) \quad , \qquad (5)$$

where SD = the standard deviation of the data.

Power Analysis

Practical use of video drops and longlines as surveying tools in the future would undoubtedly involve statistical comparisons using methods such as Student's *t*-test. We therefore evaluated our video and longline data in a power analysis for the *t*-test of means. Specifically, we estimated the sample sizes required to determine whether a 50% change in abundance could be detected using either sampling method. Skalski and McKenzie (1982) set precedence for use of the criterion of 50% change in environmental monitoring studies. The effect size (ES) was calculated as follows:

$$ES = \frac{0.693}{SD} \quad , \tag{6}$$

where, $0.693 = |\pm\ 50\%\ \text{difference in}\ x|$ for $\ln(x)$. Cohen (1988; Tables 2.3.4 and 2.4.1) was consulted for the requisite sample sizes. The ES for each gear was evaluated at $\beta = 0.20$, power $(1 - \beta) = 0.8$, and $\alpha_2 = 0.05$.

RESULTS AND DISCUSSION

General

Number and duration of video camera drops were estimated based on pilot deployments of the video system from small craft prior to cruise TC-92-04. These prior tests indicated that about 10 min was required to deploy and retrieve the camera system. Three of these tests used a complete baited camera system with approximately 20-min bottom times (total recorded time 30 min). Juvenile opakapaka occurred on all videos. The average time to first appearance (TFAP) of opakapaka on these three films was 227 ± 300 sec (mean ± 1 SD). A maximum bottom time of 10 min was chosen to include this variability and also to allow 6 drops per tape (20 min per drop x 6 drops = 2 hr). Using two cameras, 12 camera drops per day could be made without changing tapes. The maximum number of longline sets was determined, based on 3 camera drops per longline set, as four sets per day. Time for longline deployment and retrieval by the *Townsend Cromwell* averaged 30 min. During video operations on the cruise, the mean TFAP for opakapaka, for those films on which they occurred, was 203 (± 165) sec, considerably less than the 10-min bottom time chosen. The average TOTTM of opakapaka on film was 122 (± 133) sec. The MAXNO opakapaka seen on film occurred around 354 (± 153) sec, based on the nine films for which the average number ($\overline{X}_W$) of opakapaka was calculated. This also was less than the 10-min time limit.

A total of 39 longline and video stations were completed (15 at Oahu, 12 each at Maui and Kauai; Table 1; Fig. 1). Positions of longline and video camera drops are listed in the NMFS Honolulu Laboratory's Narrative Report for cruise TC-92-04 (DeMartini 1992). Depths ranged from 54-107 m for longline sets and from 52-87 m for video drops. The frequency distribution of the number of video drops completed per longline-video station is presented in Table 1. All of the opakapaka caught on the longline were juveniles, ranging from 13-21 cm fork length (FL) (R. Moffitt and F. Parrish, unpubl. manuscript; Kikkawa 1984). All of the opakapaka filmed also were juveniles, estimated to be between 13-25 cm FL. Bottom sediment composition appeared similar between windward Oahu and Kahului, Maui: mostly flat areas with fine sands and mud, many invertebrate markings, and relatively little rubble or larger structures. Bottom sediment composition off Hanalei, Kauai seemed more diverse and included areas with rubble, coarse sand, visible sand "waves," and more structure than flat areas, although some areas similar to those recorded off Oahu and Maui were observed.

Fish species and numbers caught on longlines at each site are presented in Appendix Table 1. All fish species recorded by the video camera are listed in Appendix Table 2. Total numbers, tallied for each species on video films, are equal to MAXNOs summed over each site. Figure 3 illustrates the frequency of occurrence (number of stations at which seen) of the most common species. Fish that were not caught by the longline but seen on video films were mostly reef-associated species (e.g., *Heniochus diphreutes* and *Parupeneus* spp), or sharks and rays. Both the frequency of occurrence and total number of species differ between longline catches and video films (Fig. 3; Appendix Tables 1 and 2).

Catches of *P. filamentosus* were greater for the windward Oahu site than for any other site; approximately 93% of 58 juvenile opakapaka caught on longlines were caught off windward Oahu. Puffers were prevalent at the windward Oahu and Kahului, Maui sites (Appendix Table 3). Only windward Oahu data were statistically analyzed, however, because the opakapaka data included a large percentage of "double-zero" data (zero longline catch, zero fish filmed) at the Maui (92%) and Kauai (67%) sites (Appendix Table 3).

Statistical Analysis

Analyses used log-transformed indexes to linearize data distributions (Williamson 1972). The maximum number seen (MAXNO index) for opakapaka and puffers was highly correlated with the total duration on film (TOTTM) and time to first appearance (TFAP) for both the mean of log (ML; Table 2) and log of mean (LM; Table 3) forms. The duration of squid bait (BTM index) was significantly correlated with the MAXNO index (LM form only) and the other video indexes for opakapaka ($r = \pm 0.57$, all $p \leq 0.03$; Table 3). The BTM index was more strongly correlated with the MAXNO index for puffers ($r = -0.66$, $p < 0.007$; Table 3). Videos indicate puffers were usually responsible for the removal of the squid bait, with a direct relationship between puffer numbers and the rate of bait disappearance; hence, the strong negative correlation.

The ML and LM forms of the MAXNO video index were compared separately with longline CPUE to determine which transformation provided the better correlation. The LM form of the index was slightly, but consistently, better correlated to longline CPUE than was the ML form (Tables 2 and 3) for both opakapaka and puffers. Among all indexes, the LM MAXNO index was the best correlated with CPUE for opakapaka ($r = 0.79$, $p < 0.0005$, $n = 15$; Table 3). The MAXNO-CPUE relationship is approximately linear (Figure 4A) as is its residual plot (Figure 4B). Residual scatter is homogeneous (Figure 4B), and the slope of the residuals is not significantly different from zero ($r = 0.0$, $p \approx 1.0$). If double-zero data are deleted, the correlation between the video MAXNO and longline CPUE loses significance ($r = 0.55$, $p = 0.08$, $n = 11$). The double-zero data were retained in all subsequent analyses, however, because there was no a priori reason to believe they were unrepresentative.

For puffers, the video index best correlated with longline CPUE was the index for total duration on film (TOTTM; $r = 0.59$, $p < 0.02$; Table 3), rather than the MAXNO index. A scatterplot shows an approximately linear relationship, but heterogeneous variance is apparent in the plot (Figure 5A and 5B). Interaction between the puffers and the longline may partially explain this observation. Puffers are frequently lost because they are able to effectively cut the line above the hook with their teeth (pers. observ.). It is possible to have meager (or no) catches of puffers and yet record puffers on film, sometimes in appreciable numbers (Fig. 6). Longer exposure to hooks (i.e., longer TOTTM) may allow greater catches and therefore a stronger relationship between longline CPUE and TOTTM versus MAXNO. The observed magnitude of hook loss ($\overline{x} = 32\%$, Oahu data; Appendix Table 3) indicates that longline CPUE, particularly for puffers, is fundamentally inaccurate and biased.

The observation that *L. hypselogeneion* does in fact remove hooks emphasizes the problem of hook competition between opakapaka and puffers. Usually, longline hook competition becomes a problem when hooks approach saturation (Rothschild 1967). Removal of hooks by puffers could mimic gear saturation. A multiple regression using two descriptive variables, a puffer factor (X_1) equal to the number of hooks lost plus puffer catch, and opakapaka catch (X_2) was run to determine the effect of puffers on the relation between longline CPUE and the video MAXNO index for opakapaka. Independence of X_1 and X_2 was first examined; no significant relationship was observed between the two variables ($r^2 = 0.02$, $p = 0.62$). The model (Eq. 4) for the multiple regression was forced through the origin, because neither sampling device can record the presence of fish in their absence. The total variation in the opakapaka video index explained by the model was 87% ($R^2 = 0.87$, $p < 0.001$). Opakapaka longline CPUE explained 83% of the variation ($r^2 = 0.83$, $p < 0.001$) and the puffer factor explained an additional 4% of the variation ($r^2 = 0.04$, $p = 0.07$). This indicates that the puffer factor should be evaluated in any future comparisons between video and longline indexes for opakapaka.

Precision estimates for longline and video camera were examined separately. Cameras had nominally but consistently better precision (V video LM MAXNO = 81% vs V lnCPUE = 91% for opakapaka; V video LM MAXNO = 48% vs V lnCPUE = 71% for puffers). The LM form of the video MAXNO index also had nominally better precision (V = 81%) than its ML form (V = 86%) for opakapaka. The average number ($\overline{X}_W$) of fish present on film was examined to see if a mean fish index would be less variable than the MAXNO index, but no significant decrease in variability was observed. Variability in both the longline and video data likely reflects, in part, the patchy distribution of fish. It is possible that

50-75 m was sufficient distance between the gears for one of them to sample a patch of fish that the other did not.

Power Analysis

The relative efficiencies of longline and video samplers were determined by a power analysis of a *t*-test for means. All data from windward Oahu (n = 15 stations) were first analyzed. Power was estimated only for opakapaka. Upper bounds of sample sizes for longline and video were set by practical duration of use for the *Townsend Cromwell* (a maximum of 5 days at one location) and estimates of maximum effort attainable for each gear. The latter considered the time needed for deployment, retrieval, and processing of specimens for longlines and the time required for video camera battery and tape changes. The defined upper bound for sample size was 30 stations (at 6 stations per day) for both the longline and the video cameras, with a video station consisting of three camera drops. An estimated sample size of 33 stations was required to detect a 50% change in juvenile opakapaka numbers at α_2 = 0.05 and power = 0.8 for longline sets, just slightly over the defined upper bound. A sample size of 26 stations was estimated necessary to detect a 50% change in juvenile opakapaka numbers for video drops (α_2 = 0.05, power = 0.8), slightly less than the upper bound of 30.

Power was reexamined using two video drops per station, rather than three. Power was reestimated using only those windward Oahu stations with the full complement of three drops (10 stations). The variability of the opakapaka video MAXNO index at these 10 stations, all three drops included, did not differ from the total Oahu data set (*V* = 81%). However, the sample size needed to detect a 50% change in the MAXNO index decreased to 17 stations (51 drops; α_2 = 0.05, power = 0.8). The estimated sample size for longline using data for these same 10 stations remained at 33 stations. Using only the two end-point drops of these 10 stations, variability improved about 5% (*V* = 76%), and 18 stations were estimated to be needed to detect a 50% change in the number of opakapaka seen at α_2 = 0.05 and power = 0.8. This would reduce the number of drops required from 51 to 36. The video MAXNO index remained significantly correlated with the longline CPUE for opakapaka using two drops per station (r = 0.66, p = 0.04, *n* = 10).

In conclusion, video cameras provide a quantitative tool, and the video MAXNO index could be used as a valid index of juvenile opakapaka abundance. By using a series of two camera drops per station, a minimum of 18 pairs of drops (36 drops) per study area would be necessary to detect a 50% change in juvenile opakapaka numbers. This could be accomplished within practical time limits (2-3 days) using a research vessel like the *Townsend Cromwell*. If specimens are not needed; e.g., for age-growth studies, the video system described seems to be an ideal sampling technique. Additionally, video cameras can provide important, new information on bottom type and behavior of juvenile opakapaka and associated species.

Acknowledgments

We would like to especially thank F. Parrish and S. Ellis for assistance in the construction of the video camera system, K. Landgraf for help in collecting video sample data and P. Shiota, T. Kazama, and D. Kobayashi for collecting longline sample data. We would also like to thank the officers and crew of the NOAA ship *Townsend Cromwell* for their assistance and cooperation during the collection of data on cruise TC-92-04, and R. Moffitt and W. Haight for their comments on the manuscript.

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Zar, J. H.
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Table 1.--Frequency of total number of video drops (1,2, or 3) completed per station at each island site. Each video station equals one longline station.

Island	Number of drops per station	Frequency
Oahu	1	2
	2	3
	3	10
	Total	15
Maui	1	0
	2	0
	3	12
	Total	12
Kauai	1	1
	2	3
	3	8
	Total	12

Table 2.--Correlation between mean of log-transformed video indexes (ML) and log-transformed longline catch-per-unit-effort (lnCPUE) from the windward Oahu site (n = 15). Pearson correlation coefficients (r) are displayed above their respective p-values (Prob > |R|, H_0: Rho = 0) for *Pristipomoides filamentosus* and *Lagocephalus hypselogeneion*. MAXNO = maximum number seen on film, TOTTM = total duration of a species on film, TFAP = time to first appearance of a species, and LNLLNO = longline lnCPUE .

Pristipomoides filamentosus

	MAXNO	TOTTM	TFAP	LNLLNO
MAXNO	1.0000 0.0000	0.9824 0.0001	-0.9748 0.0001	0.7759 0.0007
TOTTM		1.0000 0.0000	-0.9394 0.0001	0.7292 0.0020
TFAP			1.0000 0.0000	-0.7184 0.0026
LNLLNO				1.0000 0.0000

Lagocephalus hypselogeneion

	MAXNO	TOTTM	TFAP	LNLLNO
MAXNO	1.0000 0.0000	0.9601 0.0001	-0.6330 0.0113	0.5064 0.0541
TOTTM		1.0000 0.0000	-0.7046 0.0034	0.5352 0.0398
TFAP			1.0000 0.0000	-0.1586 0.5724
LNLLNO				1.0000 0.0000

Table 3.--Correlation between log-transformed mean video indexes (LM) and log-transformed longline catch per-unit-effort (lnCPUE) from the windward Oahu site (n = 15). Pearson correlation coefficients (r) are displayed above their respective p-values (Prob > |R|, H_0: Rho = 0) for *Pristipomoides filamentosus* and *Lagocephalus hypselogeneion*. MAXNO = maximum number seen on film, TOTTM = total duration of a species on film, TFAP = time to first appearance of a species, BTM = duration of external squid bait, and LNLLNO = longline lnCPUE.

Pristipomoides filamentosus

	MAXNO	TOTTM	TFAP	BTM	LNLLNO
MAXNO	1.0000 0.0000	0.9665 0.0001	-0.9143 0.0001	-0.5748 0.0250	0.7855 0.0005
TOTTM		1.0000 0.0000	-0.8500 0.0001	-0.5681 0.0271	0.7285 0.0021
TFAP			1.0000 0.0000	0.5729 0.0256	-0.6467 0.0092
BTM				1.0000 0.0000	-0.2982 0.2803
LNLLNO					1.0000 0.0000

Lagocephalus hypselogeneion

	MAXNO	TOTTM	TFAP	BTM	LNLLNO
MAXNO	1.0000 0.0000	0.9465 0.0001	-0.5770 0.0243	-0.6654 0.0068	0.5365 0.0392
TOTTM		1.0000 0.0000	-0.6030 0.0173	-0.5902 0.0205	0.5932 0.0198
TFAP			1.0000 0.0000	0.5141 0.0499	-0.1143 0.6851
BTM				1.0000 0.0000	-0.5193 0.0473
LNLLNO					1.0000 0.0000

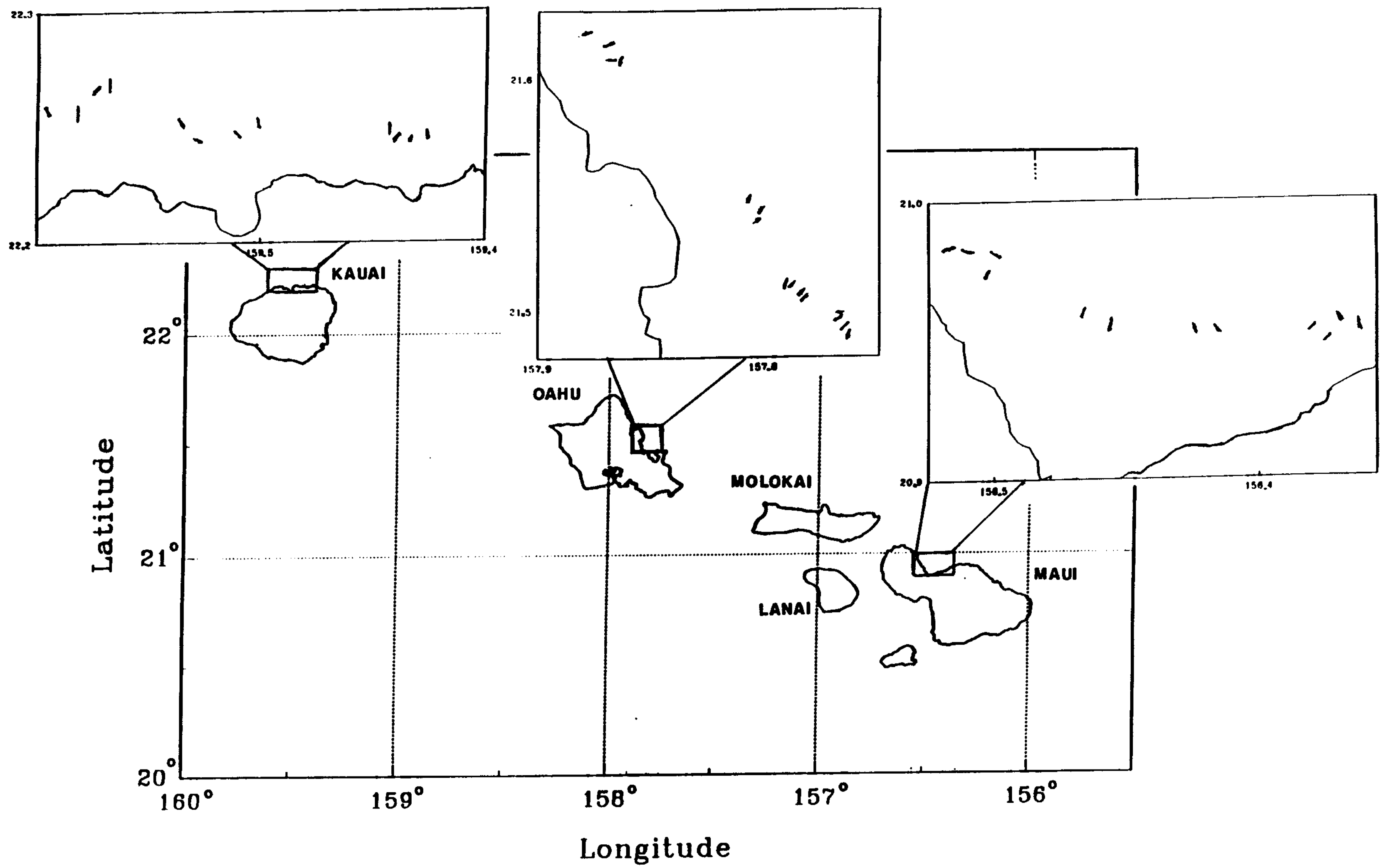


Figure 1.--Area of juvenile snapper survey of the main Hawaiian Islands with study areas enlarged for each island (insets), *Townsend Cromwell* cruise TC-92-04. The locations of longline tracks are indicated to the nearest 30.5 m^2 (100 ft^2).

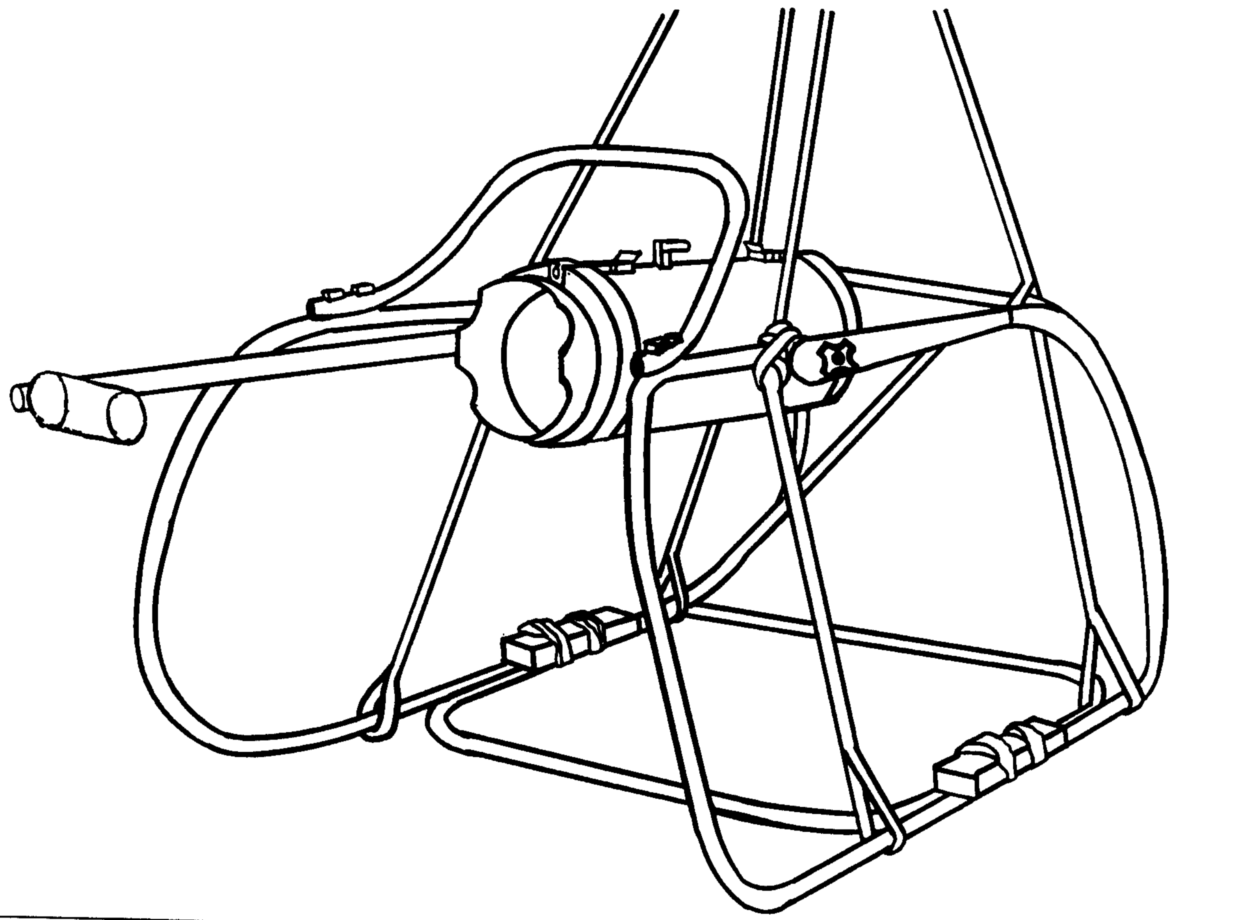
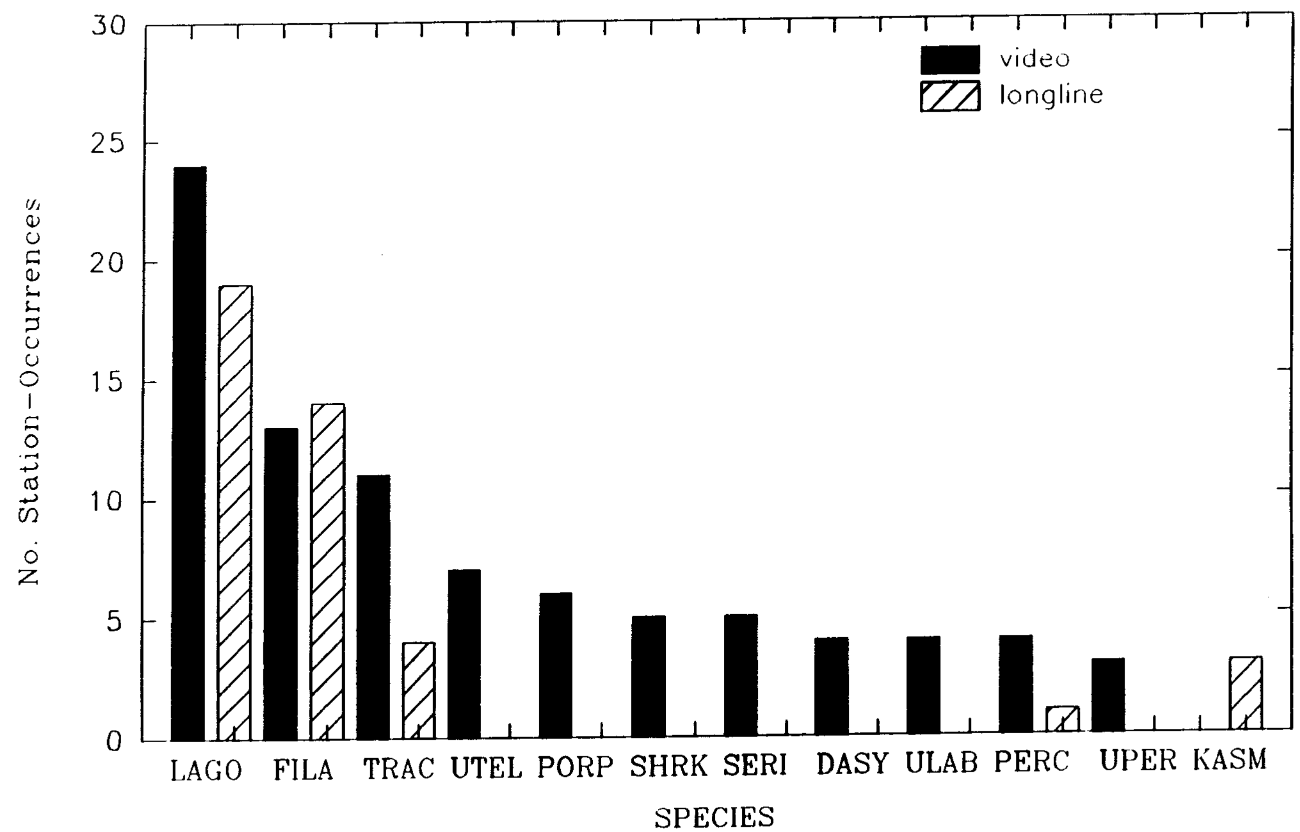


Figure 2.--Schematic of underwater video camera system with bait cannister positioned 60 cm from camera lens.



LAGO = *Lagocephalus hypselogeneion*
FILA = *Pristipomoides filamentosus*
TRAC = *Trachinocephalus myops*
UTEL = unidentified teleosts
PORP = *Parupeneus porphyreus*
SHRK = *Carcharhinus* sp
SERI = *Seriola dumerilii*
DASY = *Dasyatis* sp
ULAB = unidentified Labridae
PERC = *Parapercis schauinslandi*
UPER = unidentified Perciformes
KASM = *Lutjanus kasmira*

Figure 3.--Frequency occurrence at stations for each of 12 common species. Frequency is shown for video camera drops and longline sets separately. Total number of stations completed was 39.

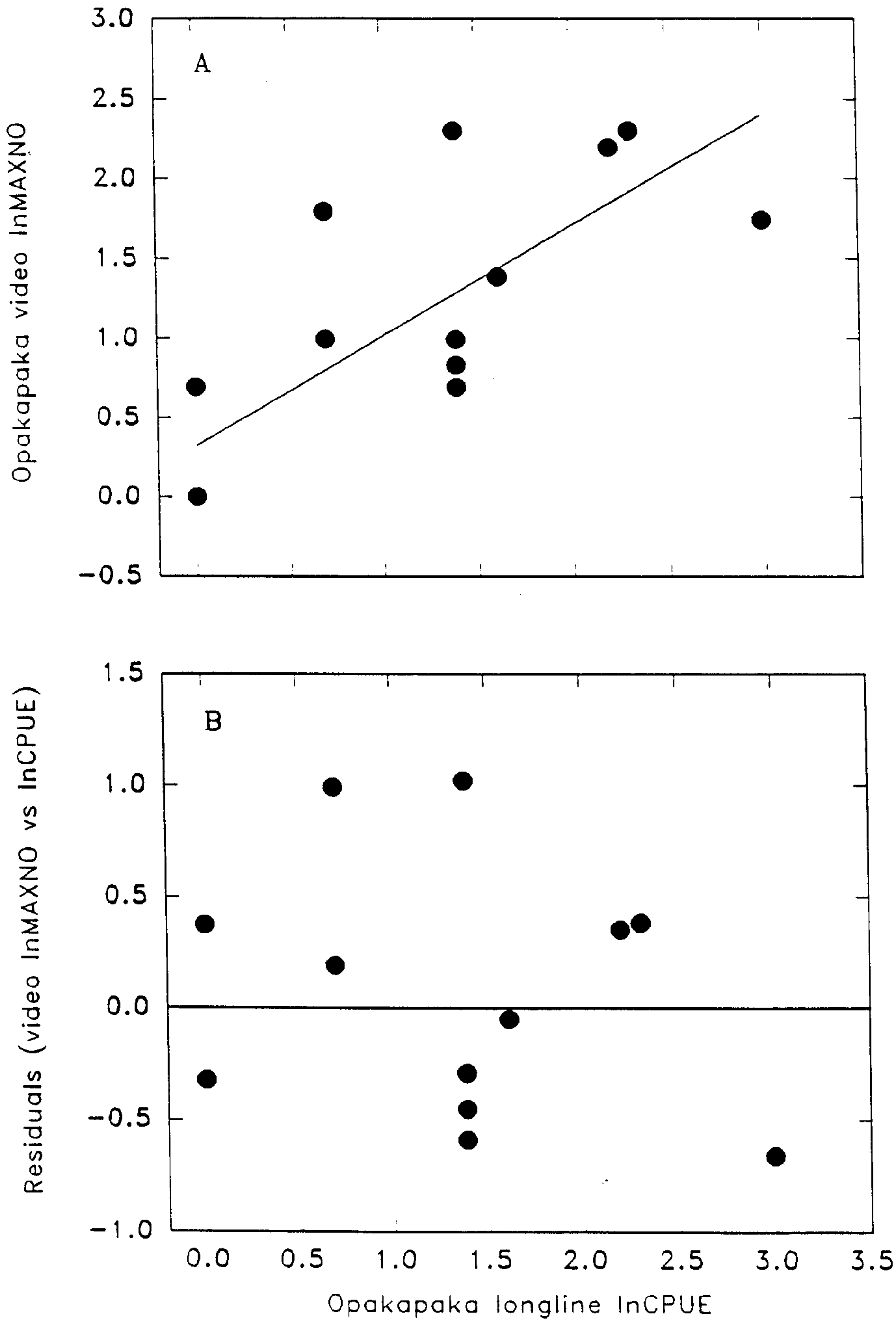


Figure 4.--(A) Scatterplot of the video index maximum number seen (ln mean MAXNO) and longline lnCPUE for *Pristipomoides filamentosus* (Opakapaka; $r^2 = 0.62$, $p < 0.001$). Data collected on *Townsend Cromwell* cruise TC-92-04, windward Oahu site ($n = 15$). (B) Plot of residuals (from the video vs longline regression) versus longline lnCPUE for *Pristipomoides filamentosus* (Opakapaka) with zero line included.

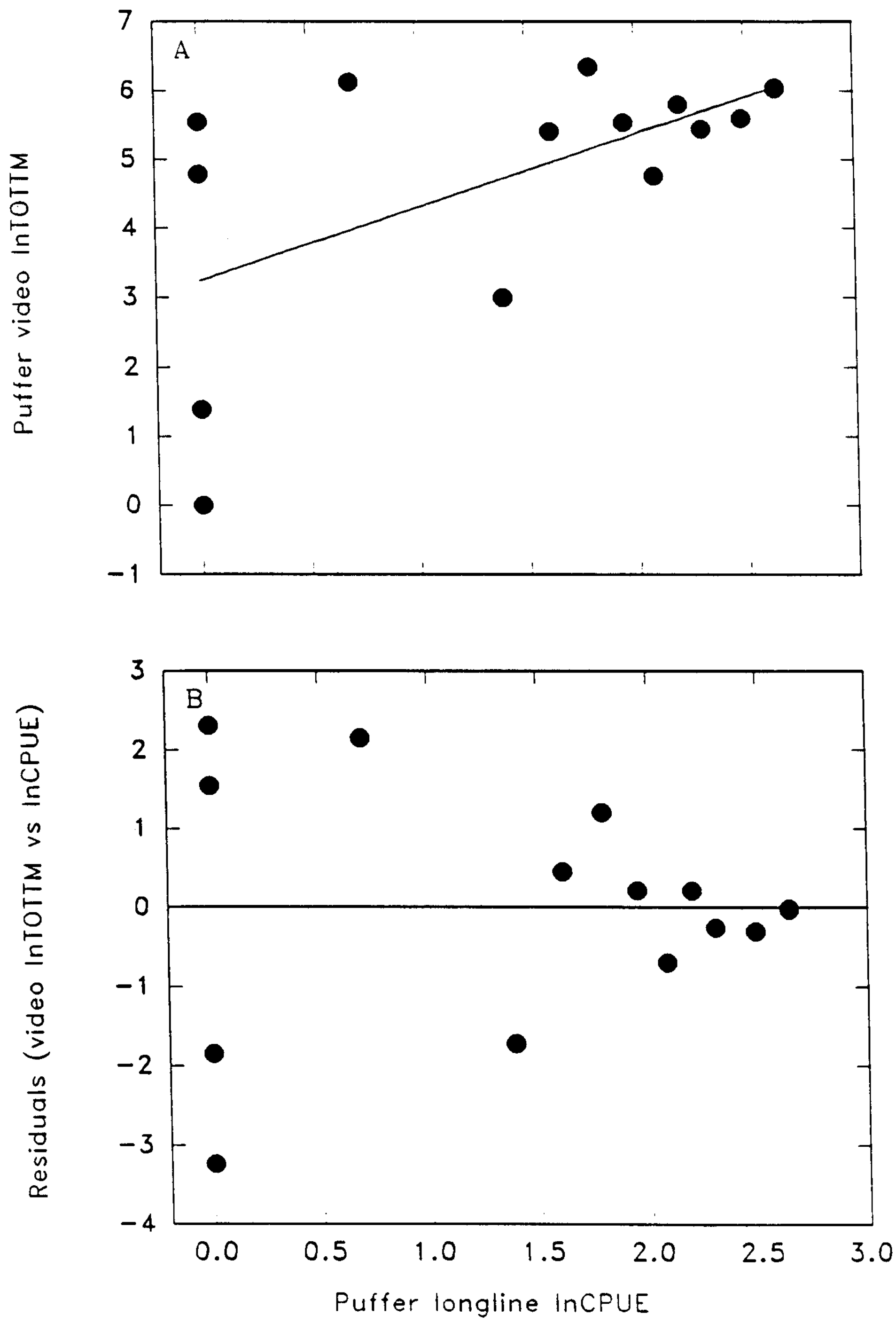


Figure 5.--(A) Scatterplot of the total duration on film (ln mean TOTTM) and longline lnCPUE for *Lagocephalus hypselogeneion* (Puffer; $r^2 = 0.34$, $p \leq 0.02$). Data collected at windward Oahu site ($n = 15$) on *Townsend Cromwell* cruise TC-92-04. (B) Plot of residuals (from the video vs longline regression) versus longline lnCPUE for *Lagocephalus hypselogeneion* (Puffer) with zero line included.

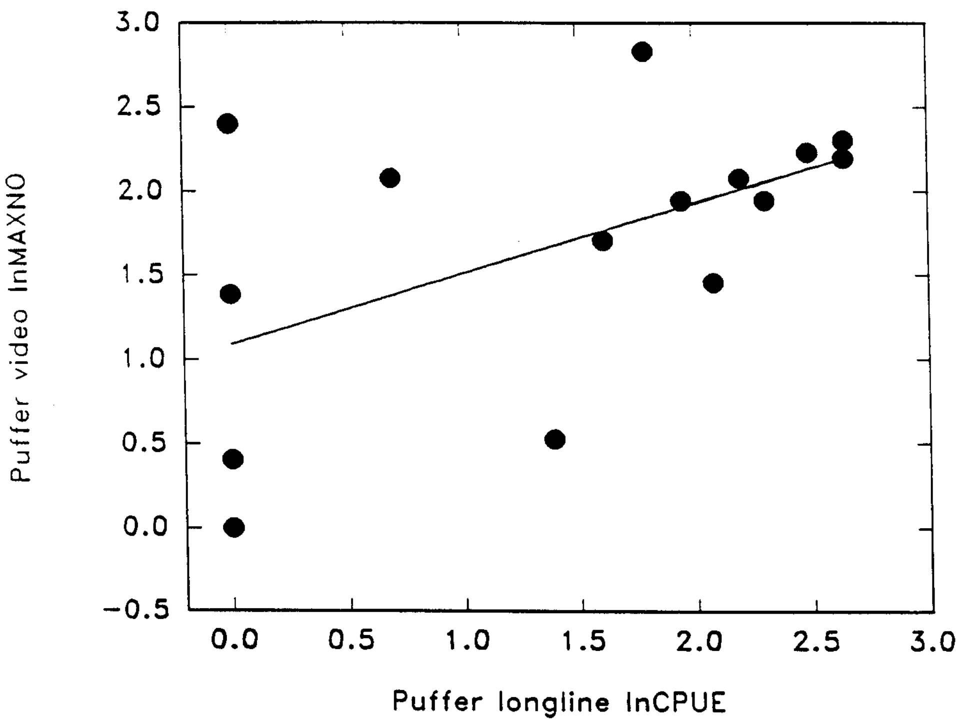


Figure 6.--Scatterplot of video index maximum number seen on film (ln mean MAXNO) versus longline lnCPUE for *Lagocephalus hypselogeneion* (Puffer). Data collected at windward Oahu site (n = 15) on *Townsend Cromwell* cruise TC-92-04.

APPENDIX

Table 1.--Summary of fish catches for 39 longline stations conducted off windward Oahu; Kahului, Maui; and Hanalei, Kauai on cruise TC-92-04. Numbers of individual species or taxa caught off each island are listed by decreasing total catch.

Species	Oahu	Maui	Kauai
Lagocephalus hypselogeneion	80	60	2
Pristipomoides filamentosus	54	1	3
Lutjanus kasmira	3	3	0
Trachinocephalus myops	0	4	0
Parapercis schauinslandi	0	0	2

Table 2.--Summary of fishes seen at 39 video stations (111, 10-min drops) conducted off windward Oahu; Kahului, Maui; and Hanalei, Kauai on *Townsend Cromwell* cruise TC-92-04. Numbers of individual species or taxa seen are listed by island. Total numbers equal the sum of the maximum number on films. Species are listed in order of total numbers seen on all (n = 111) films.

Species	Oahu	Maui	Kauai
Lagocephalus hypselogeneion	221	136	1
Pristipomoides filamentosus	94	1	8
Decapterus sp	0	50	0
Heniochus diphreutes	25	0	0
Trachinocephalus myops	5	17	0
unidentified teleosts	2	0	15
Parupeneus porphyreus	10	0	6
Parapercis schauinslandi	0	0	14
unidentified Perciformes	0	4	5
unidentified Labridae	0	0	7
Seriola dumerilii	3	2	1
Carcharhinus sp	4	2	0
unidentified Scombridae	6	0	0
Dasyatis sp	3	1	0
Parupeneus pleurostigma	1	0	3
Sphyrna sp	4	0	0
Cheatodon miliaris	3	0	0
Malacanthus brevirostris	0	1	1
Fistularia petimba	0	1	1
Bodianus bilunulatus	0	0	2
Melichthys sp	0	0	2
Canthigaster coronata	0	0	2
Parupeneus multifasciatus	0	0	2
unidentified Synodontidae	0	1	1
Sufflamen fraentatus	1	0	0
Canthigaster rivulata	1	0	0
Parupeneus sp	1	0	0
Cheilinus unifasciatus	0	0	1
Sufflamen sp	0	0	1
Coris gaimard	0	0	1
Aulostoma chinensis	0	0	1
Arothon sp	0	0	1
Leiuranus semicinctus	0	0	1
unidentified Acanthuridae	0	1	0
unidentified Bothidae	0	0	1
unidentified Balistidae	0	0	1

Table 3.--Summary of raw data indexes for longline and video for *Pristipomoides filamentosus* and *Lagocephalus hypselogeneion*. Means of the video data are used; data are recorded by station and island. Number of hooks lost (out of 150) is also noted. Longline index = no. fish caught/30 min; video index = mean of maximum no. fish seen/10 min.

Station No.	*P. filamentosus* Longline index	*P. filamentosus* Video index	*L. hypselogeneion* Longline index	*L. hypselogeneion* Video index	Longline hooks lost
Windward, Oahu					
2	0	0	0	0.5	6
3	3	1	0	3	12
4	8	8	8	7	45
5	3	9	5	16	80
7	0	0	0	10	6
8	3	1.7	13	9	40
9	1	5	13	8	73
11	1	1.7	0	0	8
12	4	3	1	7	39
13	19	4.7	3	0.7	29
14	9	9	4	4.5	38
28	0	1	6	6	82
29	3	1.3	9	6	92
30	0	0	7	3.3	74
31	0	0	11	8.3	87
Kahului, Maui					
15	0	0	13	5	34
16	0	0	11	11	28
17	1	0.3	13	13	27
18	0	0	19	8.3	23
19	0	0	0	3.3	5
20	0	0	0	0	7
21	0	0	0	0	0
22	0	0	0	0.7	7
23	0	0	0	1.7	4
24	0	0	0	0.7	2
25	0	0	2	0	4
26	0	0	2	1.7	15
Hanalei,Kauai					
32	0	0	0	0	1
33	0	2.7	0	0	5
34	0	0	0	0	3
35	0	0	0	0	0
36	0	0	0	0	0
37	1	0	0	0	3
38	0	0	1	0	1
39	0	0	0	0	10
40	1	0	1	0.5	5
41	1	0	0	0	3
42	0	0	0	0	1
43	0	0	0	0	4